Chi-Chang Chen & Chien-Chang Hsu*: **Cytological studies on Taiwan grasses (2). Chromosome numbers of some miscellaneous tribes****

陳 其昌・許 建昌*: 台湾イネ科植物の細胞学的研究 (2) 染色体数雑報**

This is the second paper on chromosome numbers of Taiwan grasses. The first paper (Chen and Hsu, 1961) was concerned with the chromosome numbers and chromosome behavior of 41 species and six varieties of the tribe Paniceae. The present paper is the result of our cytological study on some species belonging to other miscellaneous tribes. All data are listed in Table 1 to get them on record. The arrangement of tribes in subfamilies, and of genera in tribes follows Stebbins and Crampton's (1961) and Hubbard's (1934) systems respectively. References to previous records of chromosome numbers which are not available to the authors or published in a language not familiar to them may be found in Myers (1947), Darlington and Wylie (1955), Cave (1958, 1959, 1960) and Carnahan and Hill (1961).

Materials and Methods

Most of materials are collected in the field and some are grown in the greenhouse. Chromosome counts are made on pollen mother cells according to the ordinary aceto-carmine smear method. Drawings are made with the aid of a camera lucida at the magnification of 750×. Voucher specimens are deposited in the Herbarium, Department of Botany, National Taiwan University, Formosa.

Results and Discussion

ORYZEAE: As listed in Table 1, chromosome counts of *Hygroryza aristata* and *Leesia hexandra* are quite in agreement with previous reports. The genus *Zizania* has previously been reported to have two kinds of basic chromosome numbers, $x=15$ (or 5) and $x=17$ (cf. Carnahan and Hill, 1961). The present count of $n=17$ is obtained for *Z. latifolia*. Meiosis in microsporocytes of this species is found to be irregular, usually with two to four univalents at metaphase I (Fig. 1).

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CENTOTHECEAE: At diakinesis, *Lophatherum gracile* is found to have 24 small bivalents (Fig. 2). It seems that the small chromosomes of *Lophatherum* is of the oryzoid type with the basic number of 12.

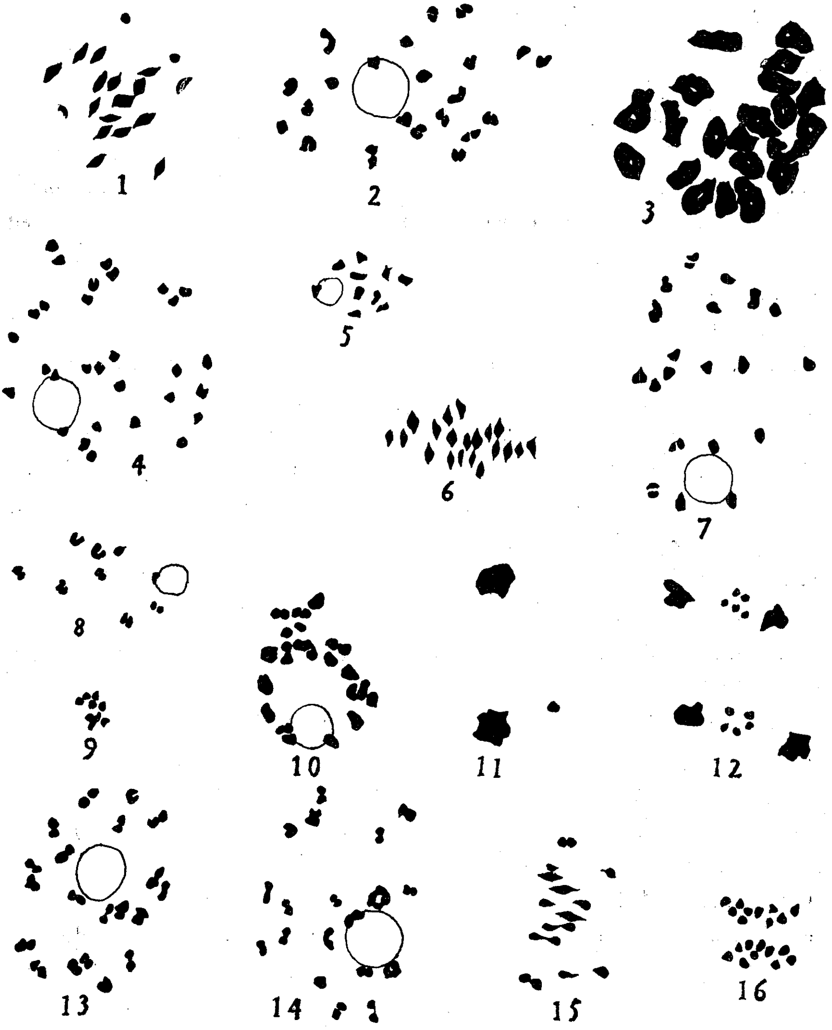
FESTUCEAE: The count of n=14 is obtained for two collections of *Poa annua*. It accords with previous reports which were made for European materials by Nannfeldt (1937), Litardière (1938), Tutin (1957), a. o., those for American materials by Armstrong (1937), Bowden (1961), a. o. and those for Japanese materials by Tateoka (1954).

TRITICEAE: A single representative from the Triticeae is *Agropyron formosanum*. Chromosome number of this species is n=21.

AVENEAE: The number n=14 is counted in the Formosan variety (var. *formosanum*) of *Trisetum spicatum*. This widely distributed species was subjected to cytological or cytotaxonomic studies by several authors (Flovik, 1938; Böcher and Larsen, 1950; Morrison, 1959; a. o.), and the tetraploid number, n=14 had been without exception detected by these authors. Counts are made of n=7 for *Alopeculus aequalis* and n=21 for *Agrostis canina* var. *formosana*, *A. clavata* var. *nukabo* and *Polypogon fugax*. These counts are in accordance with previous records (cf. Table 1).

ERAGROSTEAE: A diploid number of n=9 is observed in one collection of *Eleusine indica*, and this count accords with previous records (cf. Table 1). In a wide sense, *E. indica* includes both diploid and tetraploid plants. But after an intensive cytotaxonomic study, O'Byrne (1957) separated them at species level and gave a name *E. africana* for the tetraploid form. Chromosome counts are obtained for two species of *Eragrostis*: n=10 for *E. tenella* and n=30 for *E. nutans*. Both counts are the first cytological records.

CHLORIDEAE: Previous cytological records for *Cynodon dactylon* were 2n=30, 2n=36 and 2n=40 (cf. Table 1). A count of n=18 is obtained in the present study in agreement with the reports of Avdulov (1931) and Brown (1950). The counts are made of n=20 for *Chloris barbata* and *Enteropogon gracilior*. The chromosome of the latter species is studied for the first time in this article. The count of n=18 for *Sporobolus elongatus* is in agreement with that of Ono and Tateoka (1953). From previous records (cf. Carnahan and Hill, 1961), it is apparent that the basic numbers of *Sporobolus* are nine, ten and twelve. The single collection of *Muhlenbergia* investigated, *M. hugelii*, is a tetraploid with n=20 chromosomes. Ono and Tateoka (1953), however, reported



Figs. 1—16. P. M. C. Meiosis. 1, *Zizania latifolia* Metaphase I. 16 II+2 I. 2, *Lophatherum gracile* Diakinesis. 24II. 3, *Agropyron formosanum* Prometaphase I. 21II. 4, *Eragrostis nutans* Diakinesis. 30II. 5, *Eragrostis tenella* Diakinesis. 10 II. 6, *Enteropogon gracilior* Metaphase I. 20 II. 7, *Muhlenbergia hugelii* Diakinesis. 20II. 8, *Sphaerocaryum malaccense* Metaphase I. 9II. 9, *Sphaerocaryum malaccense* Metaphase I. 9 II. 10, *Bothriochloa glabra* var. *perfectior* Diakinesis. 19II+2I. 11, *Bothriochloa glabra* var. *perfectior* Telophase I showing one excluded chromosome. 12, *Bothriochloa glabra* var. *perfectior* Telophase II showing laggards. 13, *Capillipedium parviflorum* Diakinesis. 20II. 14, *Capillipedium parviflorum* Diakinesis. 1IV+18II. 15, *Chrysopogon aciculatus* Late metaphase I showing difference in the time of separation of bivalents. 16, *Chrysopogon aciculatus* Anaphase I showing 10: 10 distribution of chromosome.

$2n=42$ for this species.

ZOYSIEAE: Cytology of *Zoysia* had previously been studied by Forbes (1952). He reported that chromosome numbers of *Z. japonica*, *Z. matrella* and *Z. tenuifolia* were all in $n=20$ and meiosis were found to be regular. He suggested that the basic number of *Zoysia* might be 20. In the present study, *Z. tenuifolia* is confirmed to have the same chromosome number as that reported by Forbes. Although no species with 20 somatic chromosomes has been detected so far, the basic number of *Zoysia* may be ten because the number $2n=40$ in eragrostoid grasses always represent a tetraploid of the basic ten (cf. Carnahan and Hill, 1961).

PANICEAE: Cytological studies of Taiwan Paniceae were reported in the previous paper (Chen and Hsu, 1961), and only one addition is made: the count of $n=9$ is obtained for *Alloteropsis semialata*. This count accords with that of de Wet (1958), whereas the individuals with $2n=54$ belonging to this species have been reported fron South Africa (Moffett and Hurcombe, 1949; de Wet and Anderson, 1956).

ISACHNEAE: The genus *Sphaerocaryum* has not been previously studied cytologically. In the present study, it is found that chromosomes of *S. malaccense* are of the panicoid type, showing nine small bivalents at diakinesis and metaphase I (Fig. 8, 9).

ANDROPOGONEAE: Two cytological types of *Apluda mutica* have been reported, a diploid with $2n=20$ by Hunter (1934) and Celarier (1957), and a tetraploid with $2n=40$ by Avdulov (1928). In the present study, ten bivalents are observed at diakinesis.

The count of $n=18$ for *Arthraxon hispidus* is in agreement with those of Avdulov (1928) and Takeoka (1955).

The chromosome number of *Bothriochloa glabra* was recorded by de Wet (1954) as $2n=40$. In the present study of one variety, *B. glabra* var. *perfectior*, the same chromosome number is found. Meiotic behavior in microsporocytes of this variety is irregular with univalents at diakinesis (Fig. 10). It has laggards at telophase I (Fig. 11) and telophase II (Fig. 12).

Counts of $n=20$ are obtained for *Capillipedium parviflorum* and *C. assimile*. Meiotic behavior in microsporocytes of *C. parviflorum* is irregular with one large ring of four at diakinesis (Fig. 14). The same chromosome number for *C. parviflorum* had also been reported by Celarier and Harlan

(1956).

The count of n=10 for *Chrysopogon aciculatus* agrees with that of Delay (1950). There is a considerable difference in the time of separation of the bivalents at late metaphase I (Fig. 15). However, at anaphase I, most cells are normal with 10: 10 distribution of chromosomes (Fig. 16).

Ono and Tateoka (1953) reported that *Cymbopogon tortilis* had 2n=20 chromosomes. This is corroborated by the present study of meiotic chromosomes which shows n=10.

The investigation of n=20 for *Eccoilopus cotulifer* is in agreement with previous records (Ono and Tateoka, 1953; Celarier, 1956).

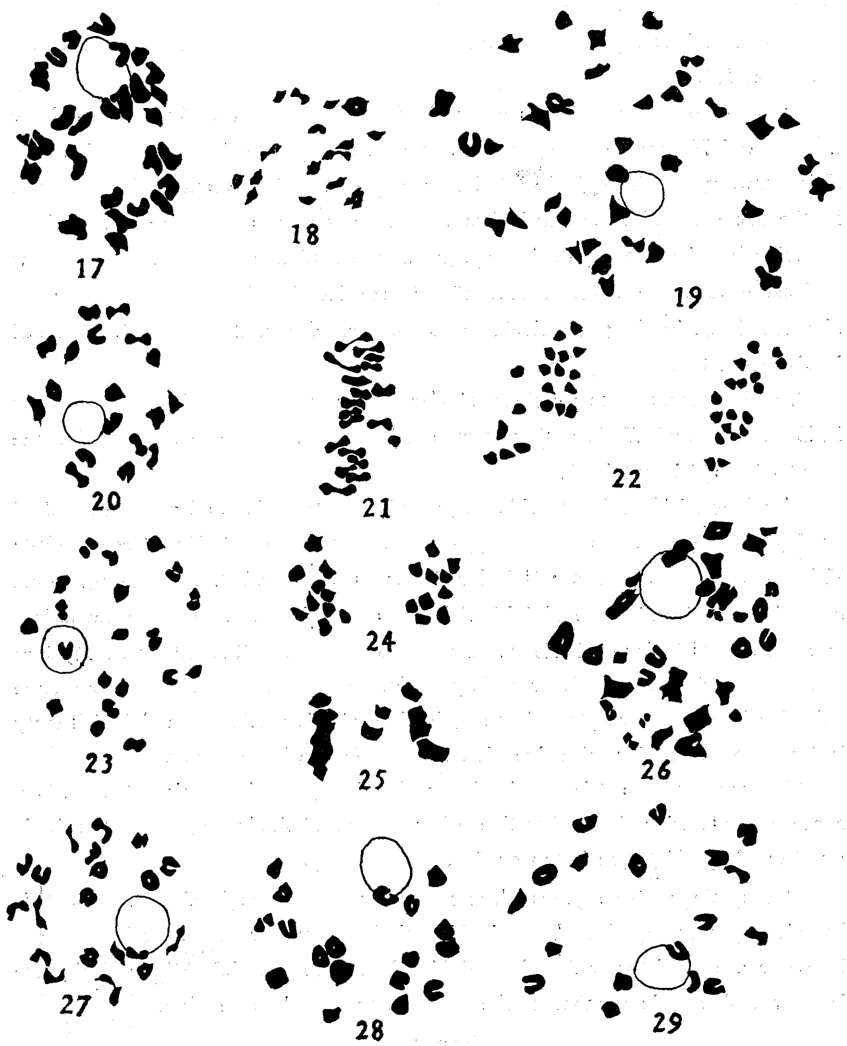
The count of n=27 is obtained for *Hemarthria compressa*. Previous counts in this genus were 2n=10 for *H. altissima* and 2n=18 for *H. sibirica* (Moriya and Kondo, 1950; Ono and Tateoka, 1953). This indicates the presence of two basic numbers, x=9 and x=5, in the genus *Hemarthria*.

The count of n=10 for *Imperata cylindrica* agrees with those of Bremer (1924), Ammal (1941) and Tateoka (1954).

Chromosomes of the genus *Ischaemum* usually clump together at metaphase I, so analysis of the chromosomal configuration at this stage is difficult. Three collections of *I. barbatum* var. *gibbum* are studied. They have 2n=36 chromosomes. Meiosis in microsporocytes of one collection, H-1122, is rather irregular. At diakinesis, quadrivalents, trivalents and univalents are observed (Fig. 19). The count of n=36 is obtained for two collections of *I. aristatum*, and their meiotic division is normal. Two clones of *I. indicum* collected from the same place are studied. One clone has normal meiotic division with 18 bivalents at diakinesis (Fig. 20), while the other clone has 2n=37 chromosomes. Observation of 18 bivalents and one univalent at metaphase I (Fig. 21) and 18: 19 distribution of chromosomes at anaphase I (Fig. 22) indicates that the latter may be a trisomic plant. No morphological differences are found between the trisomic plant and the normal plant.

Previous chromosome counts for *Miscanthus floridulus* were 2n=36, 38 and 2n=29, 35, 36, 38, 40 and 41 for *M. sinensis* (cf. Table 1). In the present study, n=19 is consistently obtained for two collections of *M. floridulus* and three collections of *M. sinensis*.

Two species of *Pogonatherum* were found in Taiwan. The one is herbaceous and the other has rather woody culms. Only *P. crinitum* is studied cytologi-



Figs. 17–29. P. M. C. Meiosis. 17, *Hemarthria compressa* Diakinesis. 27 II. 18, *Ischaemum barbatum* var. *gibbum* Metaphase I. 1IV+16II. 19, *Ischaemum aristatum* Diakinesis. 36II. 20, *Ischaemum indicum* Diakinesis. 18 II. 21, *Ischaemum indicum* Metaphase I. 18II+1I. 22, *Ischaemum indicum* Anaphase I showing 18: 19 distribution of chromosomes. 23, *Microstegium fauriei* Diakinesis. 20II. 24, *Pogonatherum crinitum* Anaphase I showing 10: 10 distribution of chromosomes. 25, *Pogonatherum crinitum* Telophase I showing laggards. 26, *Rottboellia exaltata* Diakinesis showing 10 large, 10 medium and 10 small bivalents. 27, *Spodiopogon tainanensis* Diakinesis. 20II. 28, 29, *Thaumastochloa cochinchinensis* Diakinesis. 18II.

cally. The haploid chromosome number of this specics is ten at telophase I (Fig. 25). Previous report of the chromosome number for this species was 2n=20 (Tateoka, 1956).

Chromosome count of 2n=20 for *Rottboellia exaltata* was first reported by Moffett and Hurcombe (1949) and was confirmed by Celarier (1957). However, Krishnaswamy et al. (1954) found that this species had 36 somatic chromosomes. In the present study, the third chromosome number, n=30 is presented. Meiotic behavior in microsporocytes is regular with 30 bivalents at diakinesis. It is noticeable that the chromosomes of this species fall into three groups: ten bivalents large in size; ten bivalents medium in size and ten bivalents small in size (Fig. 26).

Various chromosome numbers of *Saccharum spontaneum* have been listed in Darlington and Wylie's Chromosome Atlas (1955). In the present study, the count of n=56 is obtained.

Sorghum nitidum has a wide geographical distribution and had been studied cytologically by several authors (Ayyanger and Ponnaiya, 1941; Garber, 1950; Krishnaswamy et al., 1956; Celarier, 1958; Celaier and Mehra, 1959). Some collection are found to be diploid with 2n=10 and the others are tetraploid with 2n=20. Celarier and Mehra (1959) studied one collection from Ryukyu Islands and found that it was desynaptic. In the present study, chromosome behavior in microsporocytes of one collection of this species from Taipei County is found to be regular with five bivalents at diakinesis and metaphase I.

The count of n=20 is obtained for *Spodiopogon tainanensis*. The authors agree with Celarier (1957) that like other genera of Andropogoneae, the basic number of *Spodiopogon* is ten or five.

The cytology of the genus *Thaumastochloa* has not previously been reported. In this paper one species *T. cochinchinensis* is presented. In the species eighteen bivalents are consistently found at diakinesis and no essential meiotic difference is shown. The basic number of the genus is suggested to be nine.

Summary

1. Chromosome counts of 41 species and five varieties of the Gramineae growing in Taiwan are reported in this paper. Of these the chromosome counts of 13 species and five varieties are reported for the first time.

2. The basic chromosome number in *Sphaerocaryum* and *Thaumastochloa* is proposed to be $x=9$.

3. Meiotic abnormality is found in *Zizania latifolia*, *Bothriochloa glabra* var. *perfectior*, *Capillipedium parviflorum*, *Ischaemum barbatum* var. *gibbum* and *Pogonatherum crinitum*.

4. Chromosomes of *Rottboellia exaltata* fall into three groups indicating a possible hybrid origin of this species.

5. Both the normal and the trisomic clones of *Ischaemum indicum* are studied. The trisomic plant has 18 bivalents and one univalent at metaphase I, but telophase I shows 18: 19 distribution of chromosomes.

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Tab. 1. Chromosome numbers in some Taiwan grasses

Species	Material	**n**	Fig.	Authority (in 2n)
SUBFAMILY ORYZOIDEAE				
Tribe Oryzeae				
Hygroryza aristata (Retz.) Nees	H-856	**12**		24 Hirayoshi 1937, Ramanujam 1938
Leersia hexandra Swartz	C-4	**24**		48 Ramanujam 1938, Brown 1948, de Wet and Anderson 1956
Zizania latifolia (Griseb.) Stapf	C-97	**17**	1	17 Hirayoshi 1937, Ramanujam 1938, a. o.
SUBFAMILY ARUNDINOIDEAE				
Tribe Centotheceae				
Lophatherum gracile Brongn.	H-930	**24**	2	
SUBFAMILY FESTUCOIDEAE				
Tribe Festuceae				
Poa annua L.	C-119	**14**		28 Nannfeldt 1937, Armstrong 1937, Litardière 1938, Tateoka 1954, Tutin 1957, Bowden 1961, a. o.
〃	C-47			
Tribe Triticeae				
Agropyron formosanum Honda	C-49	**21**		
〃	H-1652	**21**	3	
Tribe Aveneae				
Trisetum spicatum (L.) Richt. var. *formosana* (Honda) Ohwi	C-57	**14**		
Agrostis				
canina L. var. *formosana* Hack.	C-12	**21**		
clavata Trin. var. *nukabo* Ohwi	C-48	**21**		
Alopecurus aequalis Sobol	C-112	**7**		14 Strelkova 1938, Johnsson 1941, Bowden 1960, a. o.
Polypogon fugax Nees ex Steud.	C-9	**21**		42 Avdulov 1931, Sokolovskaja 1938, Björkman 1954, Tateoka 1955
SUBFAMILY ERAGROSTOIDEAE				
Tribe Eragrosteae				
Eleusine indica (L.) Gaertn.	C-27	**9**		18 Avdulov 1931, Sharma and De 1956, O'Byrne 1957, Gould 1960, Singh and Godward 1960, a. o.

Eragrostis					
nutans (Retz.) Nees	C-113	**30**	4		
tenella (L.) Beauv.	C-29	**10**	5		
Leptochloa chinensis (L.) Nees	C-23	**20**		40	Avdulov 1931
Sporobolus elongatus R. Br.	C-7	**18**		36	Ono and Tateoka 1953
Muhlenbergia hugelii Trin.	C-45	**20**	7	42	Ono and Tateoka 1953

Tribe Chlorideae

Chloris barbata Swartz	C-95	**20**		20	Avdulov 1931
Cynodon dactylon (L.) Pers.	C-104	**18**		30 36 40	Hunter 1934 Avdulov 1931, Brown 1950 Hurcombe 1947, Tateoka 1954, Shibata 1957
Enteropogon gracilior Rendle	C-84	**20**	6		

Tribe Zoysieae

Zoysia tenuifolia Willd.	C-105	**20**		40	Forbes 1952

SUBFAMILY PANICOIDEAE

Tribe Paniceae

Alloteropsis semialata (R. Br.) Hitchc.	C-137	**9**		18 54	de Wet 1958 Moffett and Hurcombe 1949, de Wet and Anderson 1956

Tribe Isachneae

Sphaerocaryum malacaense (Trin.) Pilger	H-1319	**9**	8, 9		

Tribe Andropogoneae

Apluda mutica L.	C-88	**10**		20 40	Hunter 1934, Celarier 1957 Avdulov 1931
Arthraxon hispidus (Thunb.) Makino	C-126	**18**		36	Avdulov 1931, Tateoka 1955
Bothriochloa glabra (Roxb.) A. Camus var. *perfectior* (Hook. et Arn.) Ohwi	H-509	**20**			
〃	H-536	**20**			
〃	C-98	**20**	10-12		
Capillipedium					
parviflorum (R. Br.) Stapf	H-583	**20**	13, 14	40	Celarier and Harlan 1956
assimile (Steud.) A. Camus	H-549	**20**			
Chrysopogon aciculatus (Retz.) Trin.	C-26	**10**	15, 16	20	Delay 1950
Cymbopogon tortilis (Presl) A. Camus	C-99	**10**		20	Moriya and Kondo 1950, Ono and Tateoka 1953

Eccoilopus cotulifer (Thunb.) A. Camus	H-834	**20**		40 Ono and Tateoka 1953
Hemarthria compressa (L. f.) R. Br.	C-34	**27**	17	
Imperata cylindrica (L.) Beauv.	C-3	**10**		20 Bremer 1924, Ammal 1941, Tateoka 1954 24 Joshi *et al.* 1959
Ischaemum barbatum Retz. var. *gibbum* (Trin.) Ohwi	H-1122	**18**	18	
〃	C-131	**18**		
〃	H-1119	**18**		
aristatum Linn.	C-35	**36**		
〃	C-122	**36**	19	
indicum (Houtt.) Merrill	C-107a	**18**	20	
〃	C-107b	*	21, 22	
Microstegium				
ciliatum (Trin.) A. Camus	C-108	**20**		40 Celarier 1956
〃	H-1138	**20**		
〃	H-1073	**20**		
〃	Cy-012	**20**		
〃	Cy-014	**20**		
fauriei (Hay.) Honda	C-58	**20**	23	
〃	H-1677	**20**		
Miscanthus floridulus (Labill.) Warb.	C-17	**19**		36, 38 Celarier 1956
〃	C-16	**19**		
sinensis Anderss.	C-55	**19**		28 Moriya and Kondo 1950
〃	C-59	**19**		38 Leung and Li 1949, Celarier 1956
〃	C-66	**19**		
				40 Tateoka 1954
				35, 36, 38, 40, 41 Takizawa 1952
Pogonatherum crinitum (Thunb.) Kunth	C-11	**10**	24, 25	20 Tateoka 1956
Rottboellia exaltata L. f.	C-86	**30**	26	20 Moffett and Hurcombe 1949, Celarier 1957 36 Krishnaswamy *et al.* 1957
Saccharum spontaneum L.	C-92	**56**		81, 82 Moriya 1949

				96, 112 Moriya 1950 40–128 Rao and Babu 1955 a. o.
Sorghum nitidum (Vahl) Pers.	C–41	**5**		10 Ayyanger and Ponnaiya 1941, Celarier and Mehra 1959 20 Garber 1950 10, 20 Celarier 1958 10, 28 Krishnasway *et al.* 1956
Spodiopogon tainanensis Hayata	Cy–006	**20**	27	
Thaumastochloa cochinchinensis (Lour.) C. E. Hubbard	C–87 C–123	**18** **18**	28 29	

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* *cf.* text.

□井上　浩：**コケ類**—研究と採集・培養 162 pp. 8 pls. 加島書店 ¥ 300(1962) 日本のコケ（セン・タイ類）の種類に就ての書はこれまでに 1, 2 でているが，コケの一般通性に関する成書ははじめてといってよく，これまでこの種の書が渇望されていたのである。著者は極めてわかり易くコケの解説を試みて，たとえ植物学を専門に修めた人でなくても理解できるように記述してある。その範囲も，コケの代表的な種類や形態，コケのふえ方とか，一生のうちの変化，あるいは生態や分布というようなコケの性質にとどまらず，コケの利用，採集法，培養法，研究法にも広く及んで記述が進められている。書きぶりにも学問的固苦しさを和わらげる苦心が払われてあり，例えば名称も和名だけに終始して，学名は巻末に対照して記されている。その反面，最新の知識を盛りこむことを忘れてはいない。分類の基準に用いられるようになったタイの細胞内の油体とか，最も原始的なタイとして登場してきたナンジャモンジャゴケ，胞子の発芽などはそれであり，また著者の得意とする部面でもあって適切な記述がしてある。全体 150 頁そこそこの冊子ながら，63 枚の挿図と巻頭の 26 葉の立派な写真とは植物学者からさえ継子扱いを受けているコケに，新しく面白さを見出させるに十分である。また，日頃この方面に関心の乏しい人にも庭先きのコケに親近感を抱かせるよすがとなろう。（野口　彰）

□**オオイシソウの学名**　武蔵野の涌水からでる川にある特殊な淡水の紅藻として我々に親しく，*Compsopogon Oishii* Okamura の学名で日本特産とされていた。最近の論文 (Krishnamurthy. V. in Journ. Linn. Soc. London, Bot. **58** No. 372: 207–222 (1962) によると，これは北米（ガテマラ以北一帯），東南亜—東亜（印度〜日本），欧（英国）にひろく分布する *C. coeruleus* Montagne であるらしい。　（前川文夫）